Abstract of Ph.D. Thesis

"Control of Grid Interactive Microgrids Employing Solar Photovoltaic Array, Wind Turbine Driven PMSG and Battery"

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Abstract

The growing importance of sustainability and energy security is pushing the priorities of energy planners towards a larger share of renewable energy in the total energy mix. This has brought the wind-solar hybrid generation system as a part of microgrid structures to the front due to their unique advantages in terms of complementarity of generation. Therefore, this research work focuses on the development of a grid interactive multifunctional wind energy generation, which is also operable under the grid outage. Owing to the complement profiles of wind and solar, this work emphases on the development of a multifunctional microgrids employing variable speed wind turbine driven PMSG and solar photovoltaic array. Focusing on system reliability, configurations with battery energy storage (BES), integrated at DC link, are presented with and without a bidirectional converter. Moreover, functionality of the microgrids during various operating modes are discussed. A seamless transition logic in conjunction with an islanding detection technique is incorporated for transferring the mode of operation, from off grid to grid interactive and vice versa. During grid interactive mode, the system is proficient in providing power quality solutions such as, harmonics elimination, power factor correction, reactive power compensation and grid currents balancing. During off grid mode, the control objectives include voltage and frequency regulation at point of common coupling. The core objective of the system is to deliver uninterrupted power to the local critical loads even during grid outage. Based on the strength of main utility grid, strong or weak, the control algorithms for converter of grid side, are developed. An occurrence of unbalanced voltages is common for the system connected to a weak grid. The microgrid is supposed to respond these faults by remaining connected at point of common coupling (PCC) while supplying the local loads and main utility grid. Further, according to the IEEE Standard 1547.4, the microgrid is to supply reactive power to stabilize the PCC voltage. Considering the condition of weak grid and stringent grid codes, a ride-through technique is developed for the microgrid. Triggering of overcurrent protection is avoided by introducing a current limiting structure to it. The microgrid structures and the control algorithms are replicated through software simulation with the help of MATLAB/Simulink toolbox. A prototype of microgrid employing variable speed wind turbine driven PMSG, solar and BES, is developed. Moreover, the simulation results are verified with test results.